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REMARKS

The Examiner is thanked for the courtesies extended to the undersigned attorney in the telephonic interviews of January 6, 2004 and February 2, 2004. During the January 6 interview, the various rejections and objections set forth in the final Office Action of November 4, 2003 ("final Office Action") regarding the amendments to the claims, specification, and drawings to recite and illustrate first and second elongate members **501, 502** were discussed. The undersigned attorney pointed out that original FIG. 4 showed first and second elongate members, and the Examiner agreed that this figure did provide support for the amendments, as helpfully noted by the Examiner in the Interview Summary of the January 6 interview ("Interview Summary"). As such, the Examiner agreed that the objections and rejections resulting from these amendments would be withdrawn.

Moreover, the substantive rejections of the claims set forth in the Office Action of March 18, 2003 were also discussed. The Examiner correctly acknowledged that, in view of the amendments and arguments presented in the Amendment filed on July 18, 2003, the claims define over the art of record, as the Examiner also helpfully acknowledged in the Interview Summary. As such, the Examiner agreed that the substantive rejections of the claims would be withdrawn as well.

The remaining issues that were discussed during the January 6 interview are as follows:

(1) the Examiner's perceived discrepancy between the front view of FIG. 3, in which the support frames **400, 410**

appear as rounded or tubular and have a general "C" shape, and the plan view of FIG. 4 where the same support frames appear more triangular; and

(2) whether the original disclosure provides support for the addition of reference numerals **501a**, **502a**, and **501b**, **502b** respectively indicating fixed connection points between the elongate members **501**, **502** and both the shafts **200**, **210** and the pulleys **300**, **310**.

With respect to issue (1), the undersigned attorney agreed to provide a further explanation regarding the perceived discrepancy between FIGS. 3 and 4 in this Amendment After Final for the Examiner's further consideration. To this end, Applicant has prepared a series of informal drawings illustrating the CV joint of the present invention in three dimensions. During the February 2 interview, the perceived discrepancy between FIGS. 3 and 4 was further discussed, and it was agreed that the informal drawings would be incorporated in this Amendment After Final for the Examiner's reference. These drawings are set forth and discussed further below.

With respect to issue (2), during the January 6 interview the undersigned attorney argued that the reference numerals **501a**, **501b**, and **502a**, **502b** respectively indicate fixed points of connection between the elongate members **501**, **502** and both the shafts **200**, **210** and the pulleys **300**, **310**, and the originally filed specification provides support therefor. The Examiner agreed to further consider this argument in conjunction with this Amendment After Final, which is set forth in greater detail below.

In re Patent Application of:
YOON
Serial No. **09/988,881**
Filing Date: **November 20, 2001**
_____/

I. Issue (1) - Support Frames 400, 410 of FIGS. 3 and 4

Regarding issue (1) set forth above, the Examiner is correct in noting that the support frames **400**, **410** are indeed "melon shaped" in the exemplary embodiment of the CV joint illustrated in the drawings, as stated in the Interview Summary. The shape of these support frames **400**, **410** will be more readily appreciated with respect to the following informal drawings prepared for the Examiner's reference, of which:

Figure A is a perspective view;

Figure B is a front view;

Figures C-E are perspective views showing the CV joint rotated 30°, 45°, and 75°, respectively, from its position shown in Figure A; and

Figure F is a top view.

Figure A

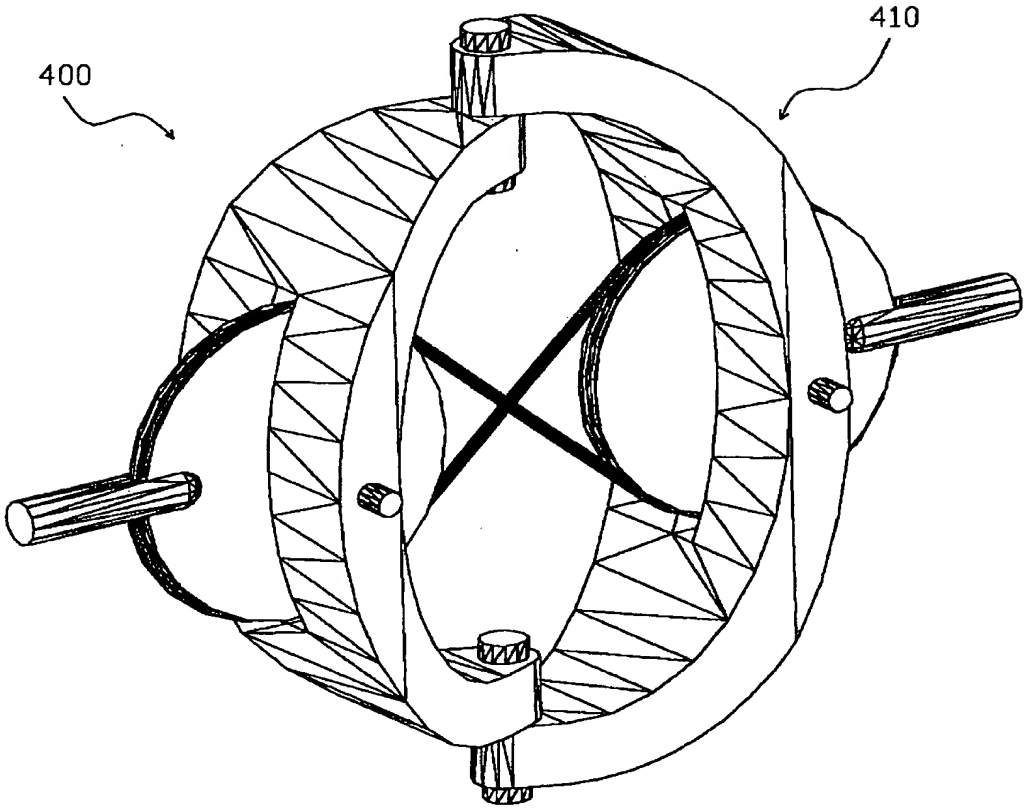


Figure B

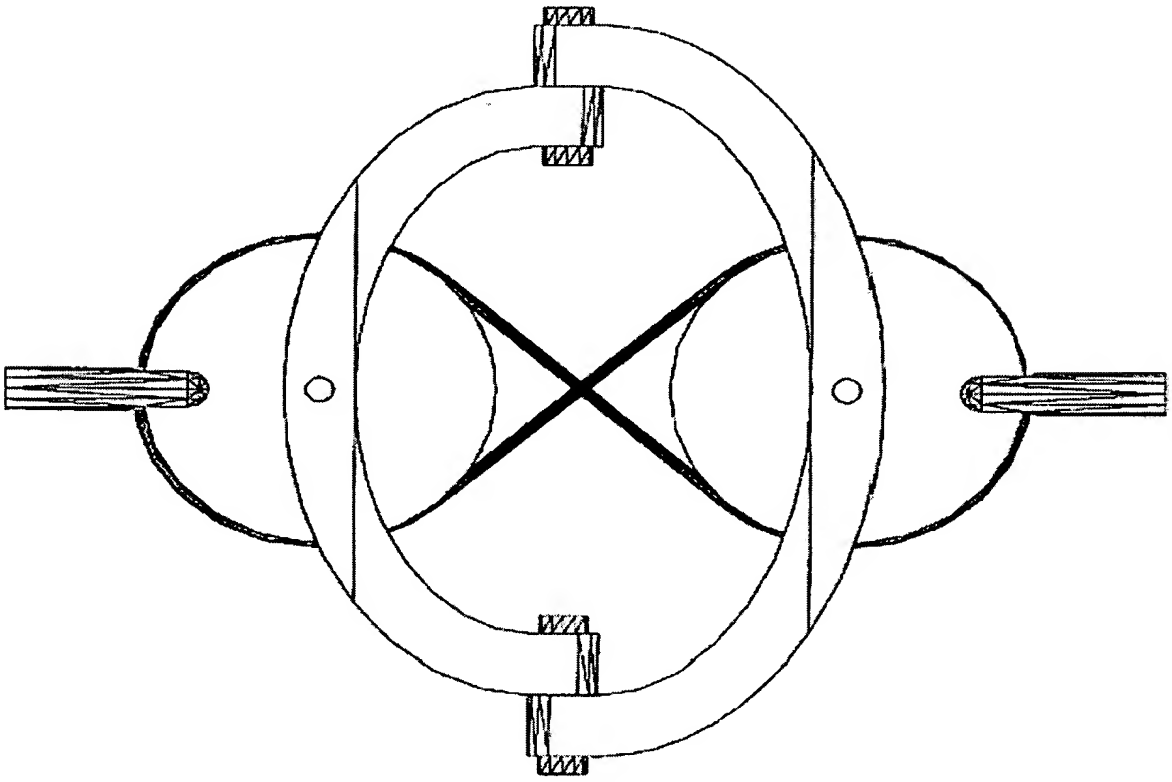


Figure C

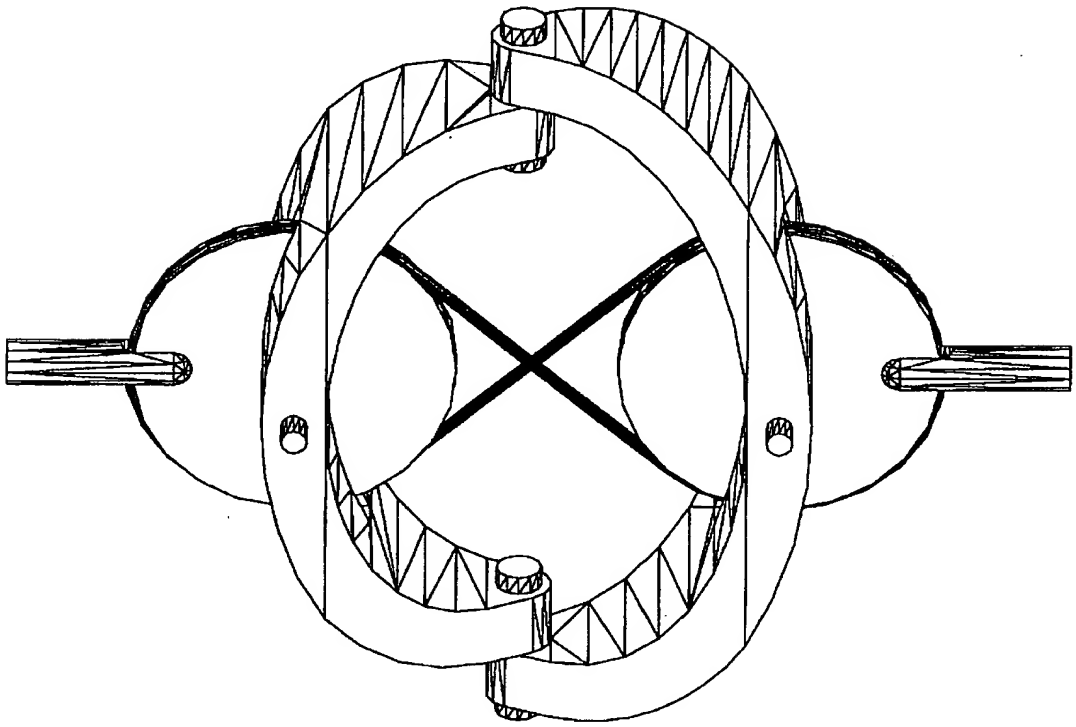


Figure D

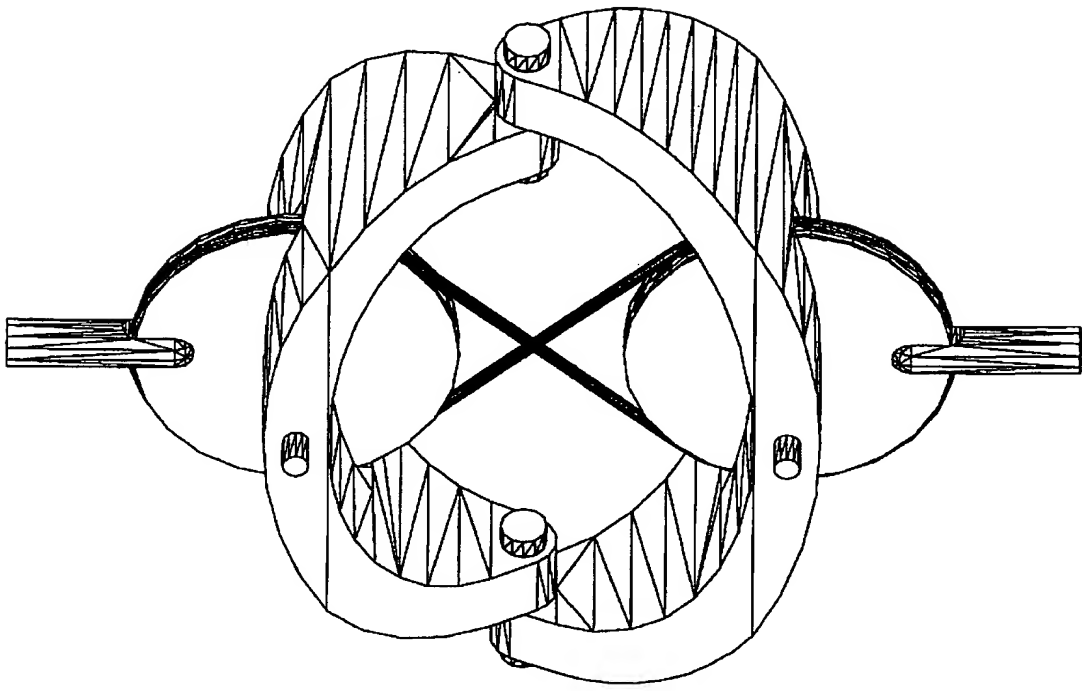


Figure E

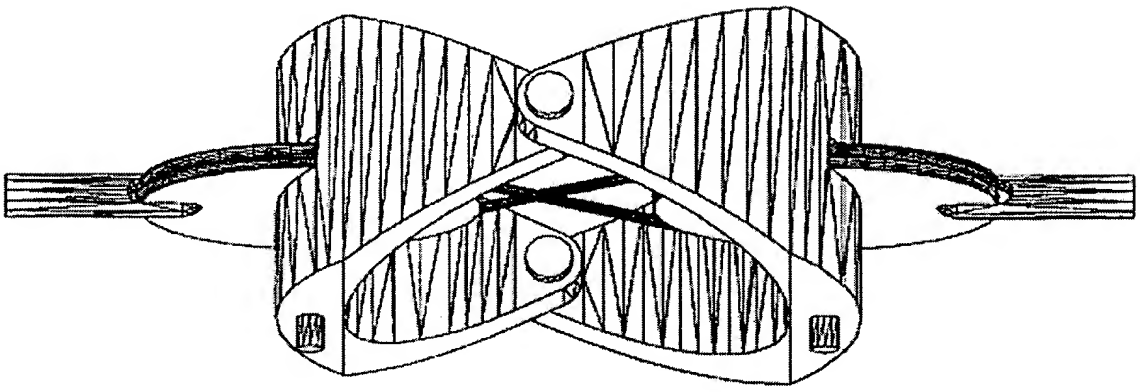
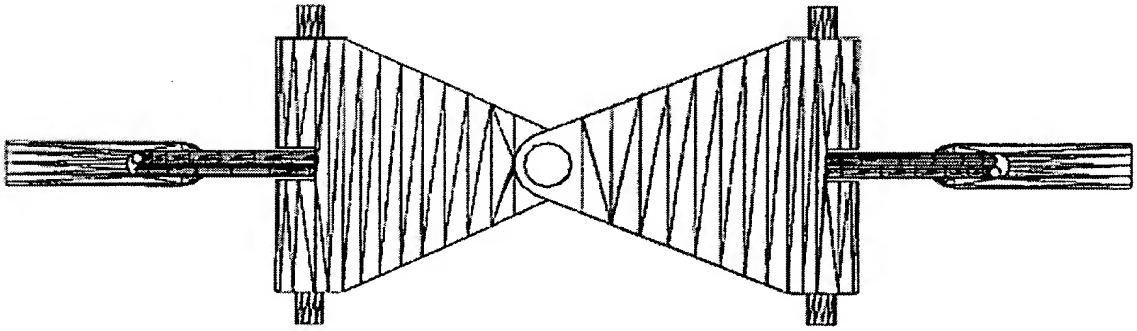


Figure F



From the three-dimensional view illustrated in Figure A, it can be seen that the support frames **400**, **410** do generally resemble a melon slice in shape. Yet, when

illustrated in a front view, as in the above Figure B (and, similarly, FIG. 3 of the application), the support frames **400**, **410** simply appear as C-shaped frames, since their three dimensional aspects cannot be seen in this view. As such, it is respectfully submitted that there is no inconsistency between the support frames **400**, **410** illustrated in FIGS. 3 and 4 of the present application, and that this objection should be withdrawn.

The Examiner did raise another perceived discrepancy between FIGS. 3 and 4 during the interview of February 3. That is, the Examiner noted that in FIG. 3 it appeared as if the shafts **200**, **210** were rotated in both the illustrated X-Z and X-Y planes. The Examiner felt this may be the case since the rotating pins **250a**, **250b** appeared to be closer to one another in the front view of FIG. 3 than in the plan view of FIG. 4, where it can more clearly be seen that there is no rotation of the shafts in the X-Z plane. The Examiner felt that if FIG. 3 was attempting to show rotation in the X-Z plane, then the support frames **400**, **410** were drawn incorrectly, as some portion of their "melon" shape (i.e., their three-dimensional aspects) would be evident.

Applicant respectfully submits that FIG. 3 is <u>not</u> illustrating any rotation of the shafts **200**, **210** in the X-Z plane, and thus the support frames **400**, **410** are accurate as currently drawn. More particularly, FIGS. 3 and 5 of the present application are substantially identical front views of the CV joint. The difference between these two figures is that FIG. 5 illustrates back-and-forth movement of the shafts in the Y direction (i.e., in the X-Y plane), as noted on page 6,

lines 14-16, and page 8, lines 28-34 of the originally filed specification. That is, the specification makes clear that FIG. 5 is only illustrating movement in the X-Y plane, and not in the X-Z plane (X-Z plane movement is shown in FIG. 6).

Yet, while FIG. 3 provides the same front view as FIG. 5, no back-and-forth movement of the shafts **200**, **210** is shown in FIG. 3 (i.e., they are only shown in a single position with force is applied thereto in the Y direction). As such, because the positioning of the support frames **400**, **410** is the same in FIGS. 3 and 5, there is similarly no X-Z movement of the shafts **200**, **210** illustrated in FIG. 3, just as none is illustrated in FIG. 5. Accordingly, the support frames **400**, **410** are correct as drawn.

Regarding the spacing of the rotating pins **250a**, **250b** in FIGS. 3 and 4, as discussed in the interview of February 2, it is respectfully submitted that this perceived discrepancy is simply due to the fact that the drawings are schematic in nature, and not drawn to scale. That is, in the front view of FIG. 3 the CV joint is more compressed so that it and the axis reference label can fit in a landscape orientation and within the prescribed drawing margins. Accordingly, there is no discrepancy between FIGS. 3 and 4, and the above-noted objection should be withdrawn.

II. Issue (2) - Illustration of Fixed Connections

It is respectfully submitted that the amendments to the specification and drawings showing a fixed connection of the elongate members **501**, **502** to both the shafts **200**, **210** and the pulleys **300**, **310** at the points **501a**, **501b**, and **502a**, **502b**.

is supported by the original specification. Indeed, the original specification describes a fixed connection to the pulleys **300**, **310** at page 7, lines 5-8, and to the inner ends of the first and second shafts **200**, **210** at page 8, lines 19-23, for example.

As shown in replacement FIG. 3 submitted on July 18, 2003, the points **501a**, **501b**, and **502a**, **502b** touch the inner ends of the shafts **200**, **210**, respectively, and therefore illustrate fixed connections thereto. Further, the points **501a**, **501b**, and **502a**, **502b** also contact the pulleys **300**, **310** and illustrate fixed connections thereto as well at the same points. While the original specification does not expressly state that the connections to the pulleys **300**, **310** occur at the same points as the connections to the inner ends of the shafts **200**, **210**, those skilled in the art will conclude that this is a logical place to make such a connection. That is, not only may a single connection (e.g., a weld) be used to simultaneously make both connections and thus save manufacturing time, but this is also perhaps the most accessible point to connect the pulleys **300**, **310** and the elongate members **501**, **502** for such a connection.

Moreover, connecting the elongate members **501**, **502** to the pulleys **300**, **310** at the ends of the elongate members as shown will provide tension to assist in keeping the elongate members within their respective groves on the pulleys along the lengths thereof. In this regard, it is worth noting that in the Thomson reference (U.S. Patent No. 6,139,437) previously cited by the Examiner, the flexible driving elements **515-518** are secured <u>at their ends</u> to the driving

pulleys **504**, **505** (see FIG. 5A and col. 21, lines 1-14 of Thompson).

Accordingly, the original specification provides support for a fixed connection to both the inner ends of the shafts **200**, **210** and to the pulleys **300**, **310**. Those skilled in the art will recognize that perhaps the most appropriate place for the latter to occur is at the illustrated points **501a**, **501b**, and **502a**, **502b**, i.e., at the ends of the elongate members **501**, **502** where connections are also made to the inner ends of the shafts **200**, **210**. Thus, while the original specification does not limit these connections to these particular locations, it does provide adequate support for the above-noted amendments to the specification and drawings, as will be recognized by those skilled in the art.

III. Miscellaneous

Lastly, the Examiner objected to the formal drawings filed January 25, 2002 for the stated reason that they did not include the reference numerals **250a**, **250b**, which were added in the amendments made to the specification in the Amendment filed July 18, 2003. Applicant would draw the Examiner's attention to the replacement drawing of FIG. 3 included with the July 18, 2003 Amendment, for example, in which these reference numerals have been added. As such, this objection should be withdrawn.

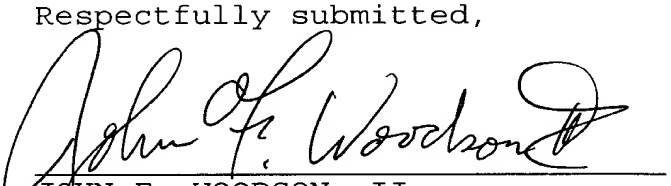
Accordingly, it is respectfully submitted that all of the objections and rejections raised in both the Office Action of March 18, 2003 and the final Office Action have been overcome, and that the amendments and drawing modifications

presented in the Amendment filed July 18, 2003 should be entered. As requested by the Examiner, included herewith is a Substitute Specification including the changes made to the specification by the July 18, 2003 Amendment (and excluding the changes made to the claims and abstract), along with an accompanying marked-up version showing the changes made.

CONCLUSIONS

In view of the foregoing, it is submitted that all of the claims are patentable, and that the application is now in condition for allowance. Accordingly, a Notice of Allowance is respectfully requested in due course. Should any minor informalities need to be addressed, the Examiner is encouraged to contact the undersigned attorney at the telephone number listed below.

Respectfully submitted,



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In re Patent Application of:
YOON
Serial No. **09/988,881**
Filing Date: **November 20, 2001**

CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: MS AF, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on this 4th day of February, 2004.

PULLEY TYPE CONSTANT VELOCITY JOINT

Field of the Invention

The present invention relates to constant velocity joints, and, more particularly, to a pulley type constant velocity joint which is capable of transmitting the rotational movement of an input shaft to an output shaft at the same velocity, and which is capable of adjusting the intersection angle of the input and output shafts within about 90°.

Background of the Invention

In general, since the wheels of an automobile are moved up and down while the automobile moves on the road, the angle between the wheel and a drive shaft is varied. A perspective view showing a conventional constant velocity joint is shown in FIG. 1, and a detailed perspective view showing the principal elements of the conventional constant velocity joint of FIG. 1. is shown in FIG. 2. As may be seen in these drawings, the conventional constant velocity joint includes input and output shafts 1 and 2 to be rotated by a driving force from the engine of an automobile, a Birfield joint 5 for adjusting the intersection angle

of the input and output shafts 1 and 2, a Birfield joint boot 3, and a dust cover 7.

Here, the Birfield joint 5 includes an outer ring 11 to which the output shaft 2 is attached. The outer ring 11 is provided in its interior with an inner surface 12. Six guide grooves 13 are formed along the inner surface 12 of the outer ring 11 at regular intervals. The inner surface 12 is formed to have a truncated sphere shape.

An inner ring 14 connected with the input shaft 1 is inserted into the outer ring 11 and has an outer surface of a truncated sphere shape. A plurality of guide grooves 15 are formed along the outer surface of the inner ring 14 to correspond to the guide grooves 13 of the outer ring 11. Also, the center of the inner ring 14 has a hole 19 to be inserted on one end of the input shaft 1.

A plurality of balls (i.e., ball bearings) 16 are inserted into the spaces defined by the grooves 13 of the outer ring 11 and the grooves 15 of the inner ring 14. Additionally, a cage 18 having holes 17 corresponding to the number of the balls 16, or the number of the grooves 13 or 15 (e.g., six) which are regularly formed, is inserted between the outer ring 11 and the inner ring 14 to hold the balls 16 at the constant positions defined by the guide grooves 13 and 15. Each ball 16 is situated between opposite guide grooves 13 and 15 and holes 17 of the cage 18. The ball 16 is slidably rotated within the guide grooves 13 and 15.

The operation of the conventional constant velocity joint as described above will now be described. Each ball 16 is situated at a constant position within two opposite guide grooves 13 and 15

when the input shaft 1 is aligned with the output shaft 2, and the ball 16 is slidably situated at a position different from the constant position within the guide grooves 13 and 15 when the input shaft 1 is not aligned with the output shaft 2. Therefore, the balls 16 flexibly transmit power from the input shaft 1 to the output shaft 2 even though the axis of the two shafts 1 and 2 are not aligned with each other.

In such a case, the inner ring 14 and the outer ring 16 are brought into contact with one point of each ball 16, respectively. Furthermore, the rotating force of the inner ring 14 is transmitted to the balls 16 through the contact points between the inner ring 14 and the balls 16, and the rotating force transmitted to the balls 16 is transmitted to the outer ring 11 through the contact points between the outer ring 11 and the balls 16.

In the conventional constant velocity joint described above, the inner and outer rings 14 and 11 may become fatigue-fractured due to the concentration of stress on the contact points, and stress may well be excessively concentrated on the balls 16. In addition, the conventional constant velocity joint typically includes contact portions and guide grooves 11 and 15, which make fabrication of the joint difficult and the structure of the joint complicated.

Moreover, the conventional constant velocity joint can allow a maximum 46.5° as the intersection angle of the input and output shafts at which the balls 16 may be kept stably within the guide grooves 13 and 15 and at which power can be transmitted from the input shaft 1 to the output shaft 2. Thus, the conventional constant velocity joint can only be used for an intersection angle of less than 46.5°.

Summary of the Invention

An object of the present invention is to provide a pulley type constant velocity joint in which an elongate ~~member~~ members or ~~wire is~~ wires are wound around the circumferential grooves of two pulleys, thereby allowing the range of the intersection angle of input and output shafts to be maximized while transmitting the velocity of the input shaft to the output shaft.

Another object of the present invention is to provide a pulley type constant velocity joint in which the ~~wire is~~ wires are wound around the circumferential grooves of the pulleys to allow the input and output shafts to maintain bilateral symmetry with each other and to transmit the axial rotation velocity of the input shaft to the output shaft to cause the structure of the joint to be relatively simple.

A further object of the present invention is to provide a pulley type constant velocity joint in which the ~~wire is~~ wires are wound around the circumferential grooves of the pulleys to transmit the axial rotation velocity of the input shaft to the output shaft and reduce the failure rate of the joint.

To accomplish the above objects, the present invention provides a pulley type constant velocity joint which may include first and second shafts for transmitting and receiving power therebetween, first and second pulleys being fixedly attached to ends of the first and second shafts, respectively, and ~~a wire~~ first and second wires wound around the circumferential grooves of the first and second pulleys to allow the first and second pulleys to be rotated with ~~reference~~ respect to the center of the first and second pulleys.

Furthermore, first and second support frames may also be included for rotatably supporting each center of the first and second pulleys, both ends of which are rotatably connected with each other. The pulley type constant velocity joint may also include two rotating pins to rotatably connect with the first and second pulleys and the frames at the centers of the first and second pulleys, and two connecting pins for connecting the first and the second frames at their ends and for allowing the frames to rotate according to the rotation of the first and second shafts.

The present invention also relates to a pulley type constant velocity joint which may include first and second shafts for transmitting and receiving power therebetween, first and second pulleys being fixedly attached to each end of said first and second shafts and symmetrically rotating with respect to each center thereof as a first degree of freedom, and ~~a wire~~ first and second wires wound around the circumferential grooves of the first and second pulleys to symmetrically rotate the first and second pulleys with ~~reference~~ respect to each of the centers. Additionally, first and second support frames may be included for rotatably supporting each center of the first and second pulleys and rotatably connecting both ends thereof as a second degree of freedom.

Further, the present invention also provides a pulley type constant velocity joint which may include first and second shafts, first and second pulleys, and ~~a wire~~ first and second wires to make the first and second shafts have a first degree of freedom and transmit and receive power therebetween. In addition, first and second support frames may be included to make the first and second shafts have a second degree of

freedom and transmit and receive power therebetween.

Brief Description of the Drawings

The above and other objects, features and other advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a perspective view showing the construction of a prior art constant velocity joint;

FIG. 2 is a detailed perspective view showing the construction of the principal elements of the prior art constant velocity joint of FIG. 1;

FIG. 3 is a front view showing the construction of a pulley type constant velocity joint in accordance with the present invention;

FIG. 4 is a plan view showing the construction of the pulley type constant velocity joint of the present invention;

FIG. 5 is a front view showing the state in which force is applied to the first shaft in a Y-axis direction and the first and second shafts are rotated; and

FIG. 6 is a plan view showing the state in which force is applied to the first shaft in Z-axis direction and the first and second shafts are rotated.

FIGS. 7A and 7B are front and plan views, respectively, showing operation of the pulley type constant velocity joint in accordance with the present invention when the shafts rotate at a respective predetermined position to transmit and receive rotating power therebetween.

Description of the Preferred Embodiments

Turning now to FIGS. 3 and 4, FIG. 3 is a front view showing the construction of a pulley type constant velocity joint in accordance with the present invention, and FIG. 4 is a plan view showing the construction of the pulley type constant velocity joint of FIG. 3. As illustrated in the drawings, the pulley type constant velocity joint 100 of the present invention includes first and second shafts 200 and 210 as input and output shafts, respectively, first and second support frames 400 and 410 for allowing the first and second shafts 200 and 210 to be rotated around rotating pins ~~250~~ 250a, 250b, and two connecting pins 450 for connecting the first and second support frames 400 and 410 to allow them to be rotated relative to each other.

Two pulleys 300 and 310 are fixedly attached to the inner ends of the first and second shafts 200 and 210. ~~An~~ First and second elongate ~~member~~ members or ~~wire 500 is~~ wires 501, 502 are wound around the circumferential grooves of the pulleys 300 and 310 ~~to cross itself~~ in a crossing position and ~~is~~ are fixed at predetermined positions 501a, 502a and 501b, 502b on the pulleys, respectively. Accordingly, if the first shaft 200 is rotated around one rotating pin ~~250A~~ 250b, the second shaft 210 is rotated around the other rotating pin ~~250B~~ 250b at the same time. Therefore, the first and second shafts 200 and 210 maintain bilateral symmetry with each other at all times. Here, ~~the wire 500 is~~ the wires 501, 502 are preferably made of metal to enhance ~~its~~ their durability.

The first pulley 300 is fixedly attached to the inner end of the first shaft 200, which functions as an input shaft, while the second pulley 310 is

fixedly attached to the inner end of the second shaft 210, which functions as an output shaft. The first pulley 300 is rotatably supported by the first support frame 400 at the center of the first support frame 400, while the second pulley 310 is rotatably supported by the second support frame 410 at the center of the second support frame 410. In such a case, a plurality of through holes are formed through the centers of the first and second pulleys 300 and 310 and the centers of the first and second frames 400 and 410, and the rotating pins ~~250A and 250B~~ 250a and 250b are inserted into the through holes.

Each of the first and second pulleys 300 and 310 has a disk shape, and each of the first and second support frames 400 and 410 has an arc shape. The disk-shaped pulleys 300 and 310 are rotatably attached at their centers to the support frames 400 and 410 by the rotating pins ~~250~~ 250a, 250b. Two couples of neighboring ends of the support frames 400 and 410 are connected by the connecting pins 450 to allow them to be rotated, respectively. The first and second pulleys 300 and 310 are secured in place by the first and second support frames 400 and 410, which have portions adjacent both sides of the first and second pulleys (see FIG. 4), and are capable of being rotated around the rotating pins ~~250~~ 250a, 250b.

The ~~wire 500 is~~ wires 501, 502 are wound around the circumferential grooves of the first and second pulleys 300 and 310 to cross itself to form a figure-eight loop. By the ~~wire 500~~ wires 501, 502, when the first pulley 300 is rotated, the second pulley 310 is rotated at the same rate in the opposite direction, thereby causing the rotation of the first and second pulleys 300 and 310 to be symmetric. Accordingly, the

first shaft 200 attached to the first pulley 300 and the second shaft 210 attached to the second pulley 310 are symmetrically rotated.

In this case, the ~~wire 500 is~~ wires 501, 502 are preferably fixed to the inner ends of the first and second shafts 200 and 210 at 501a, 502a, and 501b, 502b, respectively, to prevent the wire 500 from slipping on the circumferential grooves of the first and second pulleys 300 and 310. Two holding portions 460 are formed on both ends of each connecting pin 450, which connect the first and second support frames 400 and 410 to prevent the connecting pins 450 from being removed from the first and second support frames 400 and 410.

The operation of the pulley type constant velocity joint of the present invention will now be explained with reference to FIGS. 5 and 6. More particularly, FIG. 5 is a front view of a state in which force is applied to the first shaft 200 in the Y-axis direction and the first and second shafts 200 and 210 are rotated. Similarly, FIG. 6 is a plan view showing the state in which force is applied to the first shaft 200 in the Z-axis direction and the first and second shafts 200 and 210 are rotated.

The pulley type constant velocity joint 100 of the present invention is situated at a position where the first and second shafts 200 and 210 are connected to each other. It should be noted here that the intersection angles of the first and second shafts 200 and 210 are described relative to the XYZ axis orientation provided in ~~FIG. 3~~ the figures.

When force is applied to the outer end of the first shaft 200 in the Y-axis direction, the first pulley 300 attached to the inner end of the first shaft

200 is rotated in the direction opposite that of the first shaft 200. Additionally, the second pulley 310 is rotated in the same direction as the first shaft 200, and the second shaft 210 is rotated in the direction opposite to that of the first shaft 200. As a result, the second shaft 210 is rotated at the same angle as that at which the first shaft 200 is rotated. Each of the upper and lower intersection angles is divided into two equal angles by the line connecting the connecting pins 450.

Thereafter, when force is applied in the Z-axis direction, operation of the pulley type constant velocity joint is as follows. When force is applied to the outer end of the first shaft 200 in the Z-axis direction, the portion of the wire 500 between the first and second pulleys 300 and 310 is bent in the Z-axis direction and, at the same time, the first support frame 400 near the first shaft 200 is rotated in the same direction as that of the first shaft 200.

In this case, as the first shaft 200 is rotated, the axis connecting the two connecting pins 450 is situated on the plane dividing the intersection angle of the first and second support frames 400 and 410 into two equal angles. As described above, each of the first and second shafts 200 and 210 has two degrees of freedom in the ~~X~~ Z and Y-axes.

Next, when a driving force is applied to the first shaft 200, the operation of the pulley type constant velocity joint is as follows. The plane bisecting the supporting frames 400 and 410 passes through the connecting pins 450. This bisecting plane is always the plane of symmetry of the constant velocity joint 100. Accordingly, the first and second shafts 200 and 210 are always moving in symmetry with

respect to this bisecting plane, which is also the plane of symmetry. This symmetricalness includes the axial rotations of the first and second shafts 200 and 210. That is, the first and second shafts 200 and 210 axially rotate in the same angular velocity no matter what the angle is between the first and second shafts 200 and 210. Operation of the CV joint when the shafts 200, 210 rotate at respective predetermined positions to transmit and receive power therebetween is shown in FIGS. 7A and 7B.

As described above, the present invention provides a pulley type constant velocity joint in which the ~~wire 500 is~~ wires 501, 502 are wound around the circumferential grooves of the pulleys 300 and 310 ~~to cross itself~~ and cross one another. Thus, the first and second pulleys 300 and 310 are operated in conjunction with each other. This thereby allows the input and output shafts to be symmetrically situated and causes the rotational movement of the input shaft to be transmitted to the output shaft at the same velocity.

In contrast to the conventional constant velocity joint of the prior art, the pulley type constant velocity joint of the present invention has a relatively simple structure in which the ~~wire 500 is~~ wires 501, 502 are wound around the circumferential grooves of the pulleys 300 and 310. Accordingly, the pulley type constant velocity joint has a low failure rate due to its relatively simple structure.

Although the preferred embodiments of the present invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible without departing from the scope and spirit of the invention as disclosed in the accompanying claims.